To Dr. H. C. Yarrow
With the Compliments of
S. O. Richey

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THE PRIMARY PHYSIOLOGICAL PURPOSE OF THE MEMBRANA TYMPANI.

BY

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THE PRIMARY PHYSIOLOGICAL PURPOSE OF THE MEMBRANA TYMPANI.

By S. O. Richey, M. D., *Washington, D. C.*

In the development of anatomical structure, special organs, or parts of organs, come into existence as change of environment, or preparation for change of environment, demands them, for the perpetuation of individual existence. Aquatic animals have some peculiarity in various organs, which fits them for the medium in which they live, but these are not fitted for life in the air. Land animals by certain other peculiarities of structure are *unfitted* for existence under water. Amphibia, by organic structure, and therefore organic function, are qualified for both varieties of life.

The young of amphibians spawned in water have branchiæ, the breathing apparatus of the fish; but, with one or two exceptions, adults have lungs instead, the branchiæ giving origin to other needful appendages.

Fishes, living always in the water, have no eyelids. Many of them have movable folds, initial upper and lower lids, while in some sharks a third fold exists, forming a nictitating membrane. Most commonly the integument continues immediately into the cornea.

In reptiles and birds there are an upper and a lower movable eyelid, *and* a nictitating membrane.

In some lizzards and in serpents the eyelids are an annular fold, which becomes a pellucid, or transparent, membrane in front of the eye, *protecting the eye from the external medium.* (Gegenbauer, Comparative Anatomy, p. 532.)

The lachrymal gland appears first in amphibia and reptiles. In reptiles, birds, and some mammals, the Harderian gland, the secretion of which is not exactly like that of the lachrymal gland, opens under the nictitating membranes, or the pellucid continuation of the integument. These glands are alike in reptiles and birds.

In amphibia, even the efferent duct is foreshadowed by an epithelial development, forming a canal to carry off the secretion of the gland.[1]

The first rudiment of an internal ear is an involution of the integument into a small sac, and occurs among the lower fishes.

The crayfish has a simple auditory arrangement consisting of an auditory sac, or involution of the integument, with fluid contents, a nerve whose filaments enter auditory hairs which project into the fluid contents of the sac. No middle or external ear exists. The lamprey possesses two semi-circular canals and a sacculated vestibule, as an auditory organ. Crocodilia have external ear openings closed by a flap of the integument and this is the earliest suggestion of an *outer* or *drum-membrane* which I can find in the history of the development of animal life. The ears of birds resemble those of crocodiles.

"All amphibia have a fenestra ovalis, with a cartilaginous or osseous columelliform stapes, the expanded proximal end of which is fixed to the membrane of the fenestra." (Huxley.) Many, if not all, batrachians possess a fenestra rotunda; some have no tympanic cavity, though tympanic cavities exist in others, communicating with the throat; and tympanic membranes exist to which the stapes is attached. The tympanic membrane in the Aglossa is a cartilaginous expansion of the columella. Except the frog, most amphibia have no tympanic membrane. The fenestra *ovalis* only may be found which is connected with the exteriorly situated membrana tympani in the frog by *three* auditory ossicula. In reptiles and birds there is one columella.

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[1] Naturally here arises a question in regard to the heredity of the hyperopic eye, which is the usual form in the young of the human race. In water, the refraction of which is greater than that of the air, the refraction of the eye needs to be less than in the human being. This is fairly indicated by a comparison between the states of refraction of the eyes in savages and in civilized races; the refraction of the young and adults of civilized races, and the tendency to *increase* of refraction, by heredity and other causes, among the more highly civilized, and hence *older people*.

The auditory structures are alike in the lowest mammals and birds; they are similar in man and the higher mammals.

To sum up: The eye, the breathing apparatus, and the ear are more superficially placed in the lower forms of animal life inhabiting water. As they approach higher forms, with change of environment, they adopt certain changes of structure better adapted to their exposures.

The eye is protected, in some instances, from the desiccating influence of the atmosphere by a continuation of the integument, that part of which covering the eye becoming transparent; a tear gland is developed, supplying the eye with moisture under this covering. As this structure varies to that of two lids, which, by separating, increase the exposure of the eye, the secretion of tears becomes more than before necessary and the gland becomes more highly developed to supply the more rapid evaporation of moisture. The nictitating membrane in amphibia answers a double purpose of protection,—from the irritating effect of impure water upon eyes accustomed to the lighter medium, air; and from the irritation arising from the rapid evaporation caused by the air.

The breathing apparatus of aquatic animals, the branchiæ, being superficially placed, are, for the same reasons, unsuited to amphibious and land animals. The lungs are centrally situated; air, to reach them, must pass over a considerable extent of moist membrane and is thus materially modified. Is it not rational that for a similar purpose the auditory apparatus should be fixed farther from the surface of the body and similarly protected?

The denizen of the sea needs no conducting apparatus better than the element in which he moves, for the power of conduction of sound, inherent to the water, is less only than that of solids. Hence, an auditory sac, for the perception of sound, is all that is necessary; and we find him so supplied. The sac is kept in a condition of proper pliability by the water, and this leads us to the purpose of this paper, the important function of the membrana tympani in man.

The delicacy and pliability of the membrana secondaria must be preserved. It is therefore deeply situated, the external air reaching it only after passing over the mucous linnig of the nares, pharynx, and Eustachian tubes, and becoming so saturated with moisture and modified in temperature as not to subtract moisture from the delicate tissues of the auditory apparatus, and lessen their pliability. Is not the chief purpose of the membrana tympani to protect the tympanic cavity from the access of unmodified air in its direction? The whole structure of the conducting apparatus is subservient to the delicacy and pliability of the membrana secondaria; at the same time aiding, and not repressing, the effect of sound waves upon the labyrinthine fluid.

A perforation of the membrana tympani affects *immediately* the function of the organ little, if at all. In time, direct exposure to the air causes gradual change in the structures of the cavity, and, therefore, impaired function. The *smaller* the perforation, the more *gradual* the change; but any opening must have an effect upon the structures of the cavity similar to that of an opening into any other joint capsule, for this is to all intents a large joint.

In Stricker's Physiology, p. 969, we read: "The articulating surfaces of the ossicula resemble other true joints: they have capsules and a layer of hyaline cartilage on the articulating surface. * * * The ossicula in adults are covered by mucous membrane and a very thin periosteum."

Besides, there are other tissues in this cavity, to whose proper function moisture is necessary, and to which the action of unmodified air must prove deleterious,—muscles and membranes.

Though the articulations of the ossicula must be impaired in their movements by the chilling and desiccating effects of the air reaching them so directly, this would not necessarily express itself in impaired hearing, so long as the membrana secondaria is not stiffened, or excluded from the direct impact of sound waves by closure of the perforation in the membrana tympani.

What otologist has not seen cases in which, with an apparently normal condition of the middle ear structures, decided increase of impairment of hearing would follow a cicatricial closure of such perforation, to improve when sufficient time had elapsed to enable the tissues to become pliable from the natural secretion of the lining membrane? When the lining membrane is disabled by disease from producing this necessary moisture, the impairment of hearing is likely to persist.

We will do well to remember that the tympanic cavity is much in the nature of a serous cavity, subject to the same maladies as a joint deprived of its capsule, when the drum-membrane is removed by disease, or otherwise, or when the cavity is exposed by a persistent perforation of the membrane, though not quite so intolerant as a joint.

In amphibia the labyrinth is relatively smaller than in fishes; smallest in the mammalia.

Thus, the nearer to *full* protection from the direct action of the air, the more developed the tympanic membrane, and the deeper seated the labyrinth, *the smaller is the labyrinth and the less fluid will it contain.*

What is the relation between this fact and the processes of exosmosis from the labyrinth of the fluid contained by it, and evaporation of this fluid? In oto-sclerosis, or when perforation of the membrana tympani exists, profound, almost total, deafness may be due in part to exosmosis and evaporation of the fluid contents of the labyrinth, limiting motion of the perceptive elements by diminution of the amount of fluid in which they float, as well as by anchylosis of the ossicula, or other morbid changes of the middle ear structures.

We find in Gegenbauer's Comparative Anatomy (p.527), after his discussion of the labyrinth: "Other parts are gradually added, as accessory organs, to the auditory organ, although primarily having no relation to it." By "accessory organs" he indicates the development of the bony tympanic cavity from the first branchial cleft; the involution of the pharyngeal mucous membrane, forming the Eustachian tube; the involution of the integument, forming the external meatus; the formation, at the points of overlapping of these canals, of the drum-membrane; these two tissues, with the *membrana propria developed from the connective tissue lying between,*[1] making up the tympanic membrane. Evidently the development of these structures *subsequent* to the existence of the perceptive organ and *exterior* to it, was with a purpose other than sport. When the simplicity with which nature usually works is considered, we cannot believe it was for the purpose of making the organ more complex. Can we be certain that the existence of a transmitting mechanism improves the perception? A temporary opening of the tympanic membrane, without other tympanic structural change, does not noticeably impair hearing.

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[1] Hunt, Trans. Internat. Otol. Cong., 1876, pp. 104–112.

In view of the otherwise guarded position of the labyrinth, it is most rational to suppose the tympanic membrane exists also for that purpose; especially, with the history of the contemporary development of the eye and its appendages, and the lungs with their more central location and appendages and the protection this implies.

This theory of the primary purpose of the tympanic membrane opens up a vast field of aural therapeutics for consideration. In reading aural therapeutics, one must be often impressed with the frequency of *ad captandum* methods, and the sad experiences and failures in manipulating this obscure organ. We see the immediate effect of the air-douche; what is the remote result of its frequent repetition? What was the rationale of the endeavor to maintain an opening of the tympanic membrane in "progressive deafness," when, by proper management, the Eustachian tube could be kept patulous? Much attention has been wasted upon the drum-membrane, instead of its being devoted to the alterations in the structures behind it. The philosophy of surgical violence to this delicate organ, unless in case of destructive disease, is questionable. Nature is wise in her efforts, so persistent, to heal a drum-membrane, whether a perforation is the result of surgical violence or of disease; an effort that would indicate some other object in the existence of the membrane than the transmission of sound waves. If this were not so, why should an opening in the membrane, designed by the surgeon, close, regardless of attempts by eyelets, &c., to keep it open?

My impressions of the advisability of an imperforate membrane are so strong that I have never made one, except to evacuate fluid from the cavity. On the other hand, it has been my systematic practice for more than ten years to endeavor to close such openings. In case of chronic suppuration of the cavity, if the drum-membrane is not restored, the discharge will recur at intervals. In no case in which the drum-membrane has been restored under my observation, have I learned of a recurrence of the suppuration. This closure of the drum-membrane presupposes the destruction of the pyogenic membrane and of all germinal matter, but it also suggests some other purpose of the drum-membrane than its participation in the transmission of sound waves to the internal ear.

Conclusions.

First. The *primary* purpose of the tympanic membrane is that of protection to the tympanic cavity from the influence of the air; to prevent *parching* and *stiffening* of the membrana secondaria, the joints of the ossicula, the tendons of the tympanic muscles, and to prevent loss of labyrinthine fluid by evaporation.

Second. It, being necessary for protection of the cavity, is modified into part of a transmitting mechanism by the existence of the ossicula and their attachments: a secondary physiological purpose.

Third. A permanent opening of the membrane may, under given circumstances, *temporarily* improve the function of hearing, but is harmful to the ultimate condition of the organ.

Fourth. The tendency of the membrane to heal is an effort on the part of nature to preserve the function of hearing from the effects of disease or ill-advised surgical interference.

DISCUSSION.

DR. C. H. BURNETT:—I would like to ask Dr. Richey to read the second conclusion again.

DR. RICHEY:—"It, being necessary for protection of the cavity, is modified into part of a transmitting mechanism by the existence of the ossicula and their attachments: a secondary physiological purpose."

Dr. Burnett :—I think that I but express the feelings of all the members when I say the paper is one of great interest and value and suggestion ; and has covered the ground so thoroughly that there is scarcely anything to be said. I think there is nothing to be said in objection to it. I would merely suggest that there is a function of the membrana tympani which we might call antagonistic to the tensor tympani muscle which the doctor has not put in. I thought perhaps he would insert it under the second conclusion. I regard it as of very important consideration in respect to the function of the membrana tympani, certainly very high up in what the writer would call the "secondary function."

There is no doubt that the membrana tympani is primarily a protection from the atmosphere to the mucous membrane ; and we would certainly be confirmed in our conclusion by observing how quickly the membrana tympani tends to heal.

So far as surgical interference goes, we learn even there, if we carry it out to its ultimate conclusion, that even in the excision of the membrane, the membrane will form again. I do not think that surgery upon the membrana tympani is entirely barren, however, of results ; and there may arise cases where it should be removed surgically and where it could not possibly do any harm to the hearing (the latter already being a good deal impaired) ; and especially in cases of purulent disease of the tympanic cavity the membrana tympani may be a positive hindrance to our treatment of the purulent disease which becomes the chief consideration.

I infer from the paper that when the Doctor refers to surgical interference he means more especially cases of sclerosis which have been treated by excision of the membrane and in which he thinks that perhaps the organ and hearing are injured. I think that would be the only exception that I would take to the paper, for I believe that there may arise cases of disease — and I should perhaps limit them to purulent disease in the tympanic cavity — in which the excision of the membrane should be no longer considered as harmful. I mean those cases where the membrana vibrans is not perforated. I refer especially to those cases of perforation of the membrana flaccida and diseases of the atttic to which my paper will refer more especially. With these few slight exceptions I can say that the paper fully accords with the views I have long entertained.

Dr. John Green :—The reader has spoken of the lining membrane of the tympanic cavity as akin in a certain way to a serous membrane. I think we should take care not to lose sight of the fundamental fact that the tympanic cavity is a mucous cavity and that the only membranes which present the characters of serous sacs are the synovial cavities of the articulations of the ossicles. The diseases of the tympanic cavity certainly fall in line with diseases of mucous membranes elsewhere. The whole physiological and anatomical arrangement is that of a mucous membrane,—a mucous cavity pure and simple. I would object to the use of the term "serous" in connection with it, as tending to confusion.

Dr. W. H. Carmalt :—Another point: the mucous cavities and membranes throughout the body are developed from the so-called "external germinal layer," while the serous membranes and cavities are developed from the "middle germinal layer"; the embryological development also is different, so that they cannot be regarded in either an anatomical or embryological sense as homologous.

Dr. W. W. Seely :—One other point the author has made. as I understood it, with regard to the development of deafness in those cases of perforation of the membrana tympani. I think he claimed that there was a fixed amount of fluid—lymph, for example—in the internal ear owing to the evaporation of which deafness arose. I would like to ask if he means that there is a fixed amount of fluid, not recognizing any communication between the lymph secretion of the internal ear and the general circulation of lymph of the cranial cavity?

DR. SAMUEL THEOBALD:—I am inclined to believe with Dr. Richey that the maintenance of moisture in the drum cavity is an important function of the tympanic membrane, but I am hardly prepared to agree with him that this is its primary and most important function. The intricate structure of the ossicles, the attachment of the handle of the malleus to the tympanic membrane, and the peculiar concavity of the latter, all point to the fact that there is another very important function which the tympanic membrane has to perform. If its chief function were simply to preserve the moisture of the tympanic cavity we should hardly find such elaborate evolution of structure. The primary and most important function of the tympanic membrane, it seems to me, is to aid in the transmission of sound to the labyrinth. If I understood him rightly I should also be disposed to find fault with the comparison which he makes of the tympanic cavity to a joint cavity. The difference between the two, I think, is very wide. The tympanic cavity has a constant supply of air. The joint cavities would be in a bad way if they had a constant passage of air into them.

DR. R. TILLEY:—I think there is no doubt that a considerable number of otologists advocate in a certain class of cases that an advantage is to be obtained, in our present knowledge, from a persistent aperture in the membrana tympani; and I confess that my experience leads me to join with those who think in that particular way. I certainly have got such an improvement of hearing by an excision of a small piece from the membrana tympani, where the membrane has been considerably thickened, that it is my constant practice at the present time to excise a small piece and to try to sustain the opening. I have in mind two or three cases where I have succeeded so well that from an amount of deafness—in one instance where the watch could not be heard even on pressure and the patient expressed himself in this way: "He was so deaf in that ear that but for cosmetic effect it might be cut off"—on excision of a triangular piece in the lower and posterior part of the membrane the hearing was so improved that the watch could be heard at a distance of six or seven inches. In two cases I have been able to keep these apertures open; and as long as I have kept them open the hearing has been thus far improved. But in other cases where they have closed up the hearing has been lost practically to the same extent as it was before; so that I should differ from the doctor in the discouragement that he seems to throw on such operations. Of course if the membrana tympani is in a normal condition then there is no doubt whatever but that it is desirable to keep it normal without any aperture; but in certain conditions of thickening of the membrane, in my opinion, it is justifiable and profitable to make an opening; and I know no other way at the present time of securing the benefit than by trying to keep it open.

Dr. O. D. Pomeroy:—I do not think it is possible to get a clear and exhaustive notion as to what the membrane is good for in a general way. I remember the discussion of the American Otological Society ten years ago when Dr. Spencer, of St. Louis, reported a case where the drum-membrane became destroyed so that no vestige of it could be found. In this case a new drum-membrane was formed quite complete. After the formation of the drum-membrane the patient's hearing was not as good as before. We had a long discussion as to *what* the membrane was good for anyway. They thought in many cases it was obstructive to hearing. We all admitted that it was a good thing to close up the tympanic cavity; it did better closed than open. We observed, however, that many tympani remained open a long time and the patient did not suffer. The changes resulting from inflammation alter the original character of the drum-membrane so that you cannot take this as a basis for judgment and reason from that in estimating what the function of the normal membrane should be. You get a new formation composed of cicatricial tissues, the construction of which is not exactly known. Since that time Dr. Blake has made investigations as to the hearing power of patients under different conditions, which were published in the Transactions of the American Otological Society. He applied a great variety of nice tests and demonstrated that a thick drum-membrane was obstructive to the passage of sonorous undulations to the acousticus. The demonstration consisted in puncturing the drum-membrane, when the patient heard better. So there is no question in my mind that the drum-membrane in a state of thickening consequent on inflammation is obstructive to the hearing power.

Another function of the drum-membrane I would like to hear dilated upon. We hear a good deal about the action of the tensor tympani muscle in contracting the drum-membrane for catching one kind of sound and its relaxation for another kind of sound. This I have never seen carefully studied out. That seems to be so and yet nobody has sufficiently studied them. Different tensions of the drum-membrane evidently prepare the ear for different qualities of hearing. That seems to me to be the very reason why we have a drum-membrane, else why do we have that complicated chain of ossicles with all the details for adjusting the tensions of the drum-membrane? Nature, as a rule, does not do anything without an object. This is the principal function of the drum-membrane in my opinion,—its capacity for preparing us to hear different kinds or qualities of sound by its proper adjustment. We know very well that when we expect a cannon to be fired we adjust our ears for a powerful concussion and it does not rupture the drum-membrane. If a cannon is fired without warning it may rupture the drum-membrane. There, it seems to me, is the principal function of the drum-membrane. I have not studied it out sufficiently to satisfy myself: I don't profess to know much about it.

Dr. Sexton:—I would like to agree with Dr. Burnett and others in expressing my gratification in hearing Dr. Richey's paper, especially the researches he has made in regard to the comparative anatomy of the ear; but I think I should scarcely let the opportunity go by of rather taking issue with some of his conclusions, especially the second. I think we find that in progressive sclerosing catarrh of the middle ear a similar dry condition of the drum is found where the membrane remains intact; and it is in those cases, so far as I am concerned, that the operation of excision of the drumhead is more especially indicated and in those cases it is not entirely the admission of sound to the round window we wish to obtain but the liberation of the stapes from the chain of ossicles.

Now the practical result of operations probably is of some value in coming to a decision in regard to the value of such an operation as excision. I may state, as far as my own observations are concerned, that in a great many of the cases upon which I have operated there has been a transformation of mucous membrane lining the drum into a dermoid dry tissue, but there has at the same time been an improvement in hearing,—perhaps in part due to liberation of the stapes from the chain of ossicles as well as admission of sound to the round window; to which one of these sources of communication with the inner ear the improvement is concerned in all cases, we have not well determined. I have several cases under observation in which I have excised a large portion of the drumhead and left the stapes attached to the chain of ossicles. I propose at some time to divide that and ascertain if there is further improvement. If the improvement is simply gained from admitting air to the round window it would be unnecessary to divide that joint.

Dr. Burnett:—Dr. Pomeroy alluded to a subject in my mind,—the meeting of '76 in Philadelphia. At that time I drew attention to a point which the gentlemen present had not observed before. It was in regard to the "isolation," as the physicists term it, of the chain of ossicles maintained by the membrana tympani, as in cases of perforation. I said in discussing Dr. Spencer's paper on "the benefits of the artificial membrana tympani," that I observed in cases of perforation of the membrana tympani that the malleus was undoubtedly drawn in by the power of the tensor tympani; the antagonizing power was overcome and the malleus drawn in in consequence, and that if I would tuck a little cotton ball behind the malleus and draw it out to a normal position, the hearing was improved; and it was maintained as long as I kept the cotton there. The isolation of the chain of ossicles was thus restored and normal vibrations went on. That I regard as one of the highest functions of the membrana tympani in its normal condition, viz.: to maintain the isolation of the chain of ossicles.

Dr. Seely:—The doctor claims that the drawing in of the handle of the malleus and the apparent disturbance of the normal position of the membrana tympani has to do with a diminution in hearing. I would not call in question the statement that he restored the indrawn membrana tympani to its normal plane and thus corrected the depression of the handle of the malleus, but I am not prepared to agree with him that such restoration was the prime factor in restoring the hearing, simply because every one must have seen cases where the depression was extreme and yet the hearing is perfect so far as all tests show. Hence there must be something more than the altered plane of the membrane to account for these cases.

Dr. Burnett :—I have never seen a very retracted malleus with perfect hearing. I thought the doctor was going to say he had seen cases where the retracted malleus was restored but the hearing was not. I think such an occurrence might be accounted for in many ways : (a) If the malleus is retracted and carries the ossicles with it then the deafness is due to inward pressure of the stapes upon the "contents of the labyrinth." If anchylosis has not taken place by the time the surgeon restores the isolation of the chain of ossicles, the stapes comes out to the normal position when the retractive force is taken off. (b) The reason that hearing is not improved in other cases in which the malleus is restored to its normal position is because anchylosis has taken place between the incus, the stapes, and the oval window, the malleus remaining free.

Dr. Seely :—On the contrary the point is that you may restore the hearing perfectly so far as we can see and the appearance of the indrawing of the malleus is precisely the same as before you began your treatment. I would say there must be something else to explain this condition of things. I have seen more than one case where the appearance of the membrana tympani was not altered in the slightest and yet I know there was indrawing of the malleus, that it was indrawn thoroughly and remained so, although the hearing was, as I say, practically absolutely perfect.

Dr. Pomeroy :—I have been caught in that dilemma quite a number of times. During the winter, in the course at the Policlinic I attempt to define in great detail the appearance of a perfectly normal drum-membrane and to differentiate it from a diseased one. In spite of all the most exact observation possible I occasionally find signs of sunken drum-membrane in certain cases where the hearing is perfect. My only explanation is—that at some previous period the membrane was sunken and all the characteristics of this condition were present, including the exaggeration of the folds of the membrane. When perfect restoration took place some of these folds left ineffaceable markings. This point may be further illustrated thus : the crushing in of a stiff hat would undoubtedly leave markings which on restoring to its original shape would be likely to be still more or less noticeable.

Dr. Tilley :—My experience corresponds exactly with the experience of those who claim to have observed an indrawn and distorted membrane, associated with practically good normal hearing.

Dr. Richey :—My language in reference to opening the drum-membrane was (reading from the paper) : "The philosophy of surgical violence to this delicate organ, unless in case of destructive disease, is questionable,"—by which I refer to suppurative processes. In such cases we must reach the seat of the disease through the drum-membrane or otherwise.

I did not say "the middle ear cavity is a serous cavity." (Reading from the paper) : "The tympanic cavity is much in the nature of a serous cavity." As the paper was to be read to men who are familiar with the subject, I did not think it necessary to go into details. The secretion of the tympanic cavity is not like the mucous secretion elsewhere : it is thinner, because of the serum. When, in inflammatory excitement, the secretion is increased and we evacuate it through the membrane, it is almost always serum.

There is no fixed amount of secretion in the labyrinth, more than there is in the mouth or elsewhere. It is changing all the time. In the process of atrophy where the calibre of the Eustachian tube is much enlarged and the nares and pharynx too dry to supply moisture to the air entering the middle ear cavity in this direction, there is still evaporation and the middle ear becomes dry. There is probable movement of labyrinthine fluid towards the middle ear cavity to supply the moisture evaporated. In my opinion to this is sometimes due this gradual and progressive deafness we find in such cases, because there may exist no locking of ossicular joints; the drum-membrane is usually clear and pearly, with no change in shape from the normal,—conditions nearly always found in the early stages of this affection. Still there *is* great impairment of hearing, and I think this the most natural explanation.

Dr. Tilley believes in opening the drum-membrane. The immediate effect is probably an improvement. I would like to know for how long a time he has observed such cases. In simple perforation of the membrane or in ulceration, we know that there is progressive impairment. We see it, not in a week or a month, but in a *few years* changes have taken place in the *function* of the organ, and for that reason I think it better to close up the membrane. Dr. Pomeroy cites an instance in which the whole of the drum-membrane was absent with no impairment of hearing. "Exceptions prove the rule." I think he would not find such conditions very often. It is an isolated instance. He wants "to know what is the use of the drum-membrane anyhow." I claim that its *use* is to preserve the natural conditions of the tissues of the middle ear cavity. Nature made these in a certain way, and the membrana tympani protects them from abnormal influences. Probably, if none of us had a drum-membrane we might in time have some other tissue which would answer the same purpose. We know that nature *does* adapt us to our surroundings. In dry catarrh we have the dryness first in the nares and pharynx. I think we must go much farther than the mere locality for the pathogeny of this condition. It probably is due to some influence upon the nervous system, exerted by habits of life, or disease elsewhere, and reflected to this point. We see this in hay fever. Why should not atrophic processes have a similar origin? The enlarged Eustachian tubes are due to atrophy or to sclerosis of the lining membrane, and the air passes through them freely. It is not so rapid as with an opening in the drum-membrane, yet there is a certain amount of evaporation going on in the cavity. In this way we may explain the fact that so many of these cases make rapid progress; change in function is perceptible in a short time; then for years we see no change at all in the function of the organ. Applications to the middle ear cavity, which have a tendency to increase the secretion of the lining membrane, lessen the evaporation of fluid from the labyrinth. Upon this idea my theory of the treatment of this trouble by stimulation and increasing the secretion of the lining membrane is founded.

DR. SEXTON:—I would like to read a case. It is from the advance sheets of my work on the ear, now in press. Case 30. Female, 27 years of age, had been suffering from deafness in the right ear for some two years past, accompanied by tinnitus. The operation undertaken on November 11, 1886, consisted in making a large opening with sulphuric acid in the posterior segment of the right drumhead and dividing the incudo-stapedial joint. To prevent reunion of the latter, the attached end of the long process of the incus was amputated. The parts healed up quickly, leaving a large opening in the drumhead through which the lower end of the long arm of the incus and the stapes could now be plainly seen. The patient could previously hear shouting only in the right ear at twenty feet as noise; she can hear now ordinary voice beyond twenty feet. There is general improvement in the health of the patient and the tinnitus ceased immediately after the operation. That case is now in as good condition as at the time of the operation—November, '86.

DR. RICHEY :—That is probably one of those exceptional cases. It seems so to me. How many of them have you seen?

DR. SEXTON :—I have reported here some half dozen cases of that kind. I tabulated these some six months ago. I do not at this moment know how many I have seen. That is an exceptionally good result. I have seen good results that have remained when last seen after the operation one or two years.

DR. RICHEY :—There is in human beings a difference in their power of resistance, and we may find under exposure to exceptional influences a power of *exceptional* resistance in a limited number of cases. I would like to know the final result in the case mentioned by Dr. Sexton. Such experience, if general, would very much modify my opinion. While I have the floor I would like to make a suggestion in answer to Dr. Pomeroy in regard to the tympanic muscles. It has never been my impression that the purpose of the tympanic muscles is alone to increase or modify the hearing power; but that they are intended as a help to the drum-membrane, in resisting compressed air from without; in other words, if one be standing near a cannon and *knows* it is going to be fired, he will probably not have a ruptured drum-membrane, nor the stapes driven into the oval window; but if he is not prepared for the explosion he can not adjust the drum-membrane. This adjustment is an involuntary process, just as closing the eyelids for protection to the eye. We know that the membrana secondaria is intended to permit motion in the labyrinthine fluid in response to the motions of the stapes. If a sound wave contributes a certain amount of motion to the stapes, this puts in motion the fluid of the labyrinth, and the membrana secondaria moves to allow this motion; whereas if the membrana secondaria is stiffened the movement of the fluid is lessened and there is less motion of the foot of the stapes, with a greater tendency to anchylosis. I think this is the way, probably, in which many of our cases of stapedial anchylosis occur. I also think rheumatic arthritis has much to do with that.

DR. BURNETT:—I should like to ask whether Dr. Richey really means evaporation to or from the labyrinth? Now, osmosis might take place; but I don't think the gentlemen present can admit that evaporation as such can take place from the labyrinth by way of the tympanic cavity when the latter is open. The labyrinth is an air-tight cavity.

DR. RICHEY:—I think the gentleman would have to prove that through the membrana secondaria there is no possibility of such a passage. In most membranes of the body we find that it is so. We know this tendency in membranes of any kind, even if almost fibrous, that if dry on one side, with fluid on the other, the fluid is apt to pass through.

DR. BURNETT:—That is osmosis, but not evaporation.

DR. RICHEY:—Evaporation takes place after it passes through the membrana secondaria. I claim that when deprived of the secretion of the tympanic cavity the membrana secondaria is drier than it should be on the tympanic side, the fluid of the labyrinth finds its way through the membrana secondaria, and follows the course of the fluid of the tympanic cavity, is in turn evaporated, thus diminishing the amount of labyrinthine fluid.

DR. SEXTON:—I would suggest that a man cannot prevent rupture of the drumhead, even if conscious, from loud sound of cannon, if in or near the blast of the discharge.

DR. RICHEY:—Dr. Sexton's objection is well taken. I used the "explosion of cannon" to illustrate my meaning.